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BOTANY.—*Certain Desmonci (Palmae) of Central America and Mexico*,¹ H. H. BARTLETT, University of Michigan.²

The genus *Desmoncus* provides one of the characteristic features of tropical American vegetation. It is often remarked that in the western hemisphere the *Desmonci* take the place of the far more viciously armed climbing palms of the Oriental tropics, such as *Calamus* and *Daemonorops*, which are systematically not closely related, but in their climbing habit, armature, and ecological relations offer some points of resemblance.

To secure specimens of the climbing palms takes much of a collector's time and effort, since they are often not found in fertile condition or easily secured even if found, because of their spininess and difficulty of disengaging them from the limbs of the trees through which they clamber. Good specimens are therefore disproportionately rare in our herbaria, in consideration of their importance in the composition of the tropical forest. Many of the described species are inadequately known, and it has become customary to use a few names as catch-alls for very distinct plants.

It appears that the species of *Desmoncus* are in reality rather local in distribution, and that much careful work on the part of collectors and herbarium botanists will be required to ascertain their ranges and characteristics.

In British Honduras and Guatemala the writer came in contact with a group of *Desmonci* related to *D. chinantlensis* Liebm., which

¹ Received November 20, 1934.

² Papers from the Department of Botany and the Herbarium of the University of Michigan, no. 508.

was described from Mexico and remains very inadequately known. These related plants of northern Central America are called "basket tie-tie" or "basket whist" by the inhabitants of British Honduras and "bayal" by the Spanish-speaking people and the Maya. In British Honduras any vine is a "tie-tie," and the *Desmonci* are the particular "tie-ties" of which baskets are made—whence the name.

Either there are many local species with rather slight distinctions, as the writer believes, or else there is a very wide-spread species, *Desmoncus chinantlensis* Liebm., made up of a group of varieties, or (as some botanists might even conclude) of taxonomically negligible variations. Several of these minor species are here described. There are indications in the herbaria that other species of the same order of distinctness remain to be described, but unfortunately entirely satisfactory material is lacking.

In addition to the species related to *D. chinantlensis* there are others farther south in Central America which have quite different relationships. It is evident that the alliance of *D. chinantlensis* does not hold the field alone much south of Guatemala, although Bailey³ found a species in Panama which he has tentatively referred to it.

There is some question as to the interpretation of Liebmann's *D. chinantlensis* which might best be cleared up by renewed collecting and study at the type locality. Bailey refers to a sheet at Copenhagen as the type specimen (Liebmann no. 6595), and remarks that it does not agree with two specimens in the United States National Herbarium (Liebmann nos. 6594 and 6596). Since the original description (Martius, *Historia Palmarum* 3: 321. 1850) cites no specimen whatever, it seems best to typify the species by a specimen or specimens conforming as closely as possible with the original description, and from this standpoint the specimens in the United States National Herbarium may be fairly viewed as cotypes. I have considered them as such in my interpretation of the species. The justification for so doing lies in the fact that the *Desmoncus* from Barro Colorado Island, Panama, which Bailey figures and which agrees with the particular Liebmann specimen (no. 6595) that he regards as the type of *D. chinantlensis*, does not conform to the original description. It appears to lack the beard of spines on the upper side of the base of the leaflet, which is characteristic of the entire alliance of *D. chinantlensis*, and which Liebmann refers to in the description ("pinnis . . . antice juxta nervum aculeatis"). Bailey's Barro Colorado plant also agrees with Liebmann's no. 6595 in having "thin, not stiffly veined glabrous pin-

³ BAILEY, L. H. *Certain palms of Panama*. *Gentes Herbarum* 3: 31-116. 1933.

nae 8 inches or less long." On the contrary, the two Liebmann specimens in the National Herbarium have, as Bailey says, "different looking, very costate pinnae and much smaller spines." Referring again to Liebmann's original description, we find that the lower leaflets should be 9 inches long, not 8 or less, and that the pinnae should be strongly plicate ("*pinnis . . . valde plicatis*") rather than "thin, not stiffly veined." Furthermore, Liebmann describes a type with dimorphic spines on the petioles and lower rhachis, and with the leaflets irregularly aggregated, whereas Bailey's species, which agrees with Liebmann 6595, has (according to the figure) spines of a single type and pinnae "mostly opposite or subopposite." In view of the discrepancies between Bailey's plant and the Liebmann description of *D. chinantlensis*, I have preferred to interpret the latter as being really represented by Liebmann's nos. 6594 and 6596 in the United States National Herbarium.

The entire alliance of *Desmoncus chinantlensis* lacks hooked prickles, has a beard of *aciculae* on the upper surface of the leaflet near the base, and is presumably characterized by nine rather than six stamens, although not all of the species are known from flowering specimens. Leaving out a couple of species which are doubtless distinct, but of which the material is inadequate for description, the group may be arranged as follows:

- Corolla of female flower containing at one side of the ovary a fimbriate, oblong, basally attached scale as long as the corolla lobes; leaflets only about 1 cm. broad.....*D. anomalus*
- Corolla of female flower containing no such scale; leaflets over 2.5 cm. broad.
- Axis and branches of inflorescence thick and somewhat fleshy.....
-*D. chinantlensis*
- Axis and branches of inflorescence thin, not fleshy.
- Rhachis even if short-aciculate also armed below the middle with a few distant retrorse or subretrorse spines which are the longest ones on the plant.
- Inferior spathe aciculate: female flowers with annuliform-cupulate calyx, very obtusely 3-apiculate and corolla broader than high, nearly evenly truncate, but sharply though minutely 3-apiculate.....*D. Lundellii*
- Inferior spathe entirely or nearly unarmed: female flowers with acutely triangular-cupulate calyx and corolla higher than broad with margin 3-apiculate from deep rounded sinuses.....
-*D. quasillarius*
- Rhachis sparsely to densely aciculate with spines no longer than those on other parts of the plant, and not clearly dimorphic.

Inferior spathe almost unarmed.....*D. uaxactunensis*
 Inferior spathe aciculate: corolla of female flower broader than high,
 obtusely 3-apiculate with shallow obtuse sinuses.....*D. ferox*

***Desmoncus anomalus* sp. nov.**

Scandens pergracilis. Vaginae pars superior (ochrea) 12 mm. diam., 22 cm. longa albida, cinnamomeo-furfuracea, subappresse aciculata, aciculis majoribus 8 mm. longis, juventate ferrugineo-pubescentibus. Petiolorum 1.5 cm. longus, debiliter et breviter aciculosus. Rhachis petiolo similis 165 cm. longa subtus subinermis, furfuracea, supra sparsim armata, aciculis majoribus 12 mm. longis. Foliola utrinque ca. 19, basi debiliter aciculata inferiora ca. 22 cm. longa, 7 mm. lata in filum attenuata; mediocria ca. 21 cm. longa, 10-12 mm. lata; superiora 24 cm. longa, 8 mm. lata, caudato-acuminata. Foliolorum paria intermedia in uncos transeuntia reflexa, ca. 14 cm. longa, 2 mm. lata. Uncorum paria 10 debilia, inferiora ca. 12 cm. inter se distantia, 6 cm. longa, superiora 1.5 cm. distantia, 2.5 cm. longa. Cirrhus omnino inermis. Spatha inferior 28 cm. longa, 14 mm. lata, sparsissime breviterque appresso-aciculata. Rami fertiles pars inter spathas 29 cm. longa, 10 mm. lata, compressa, sparsim appresso-aciculata. Spatha superior deest. Pedunculus 6 cm. longus, aciculas 4-10 mm. longas ferens. Rhachis ramifer 20 cm. longa, albida, sparse ferrugineo-furfuracea; ramis floriferis ca. 35 valde flexuosis, inferioribus 12 cm. longis. Flores inferiores terni, bracteolis 1 vel 3 firmis brevissimis anguste lunulatis vel canaliculiformibus apiculatis subtenti. Flores feminei centrales; gamopetali et gamosephali. Calyx subannuliformis vel circumscriptione rotundato-triangulus, angulis obtusissimis rotundatis. Corolla (solum vetusta fructibus delapsis visa) obtusissime apiculata, unilaterally includens squamam lobis corollae 2.2 mm. longis propriis aequilongam et 2 mm. latam apice fimbriatam. Staminodia vestigialia basi corollae connata. Pistillum et fructus desunt. Flores masculi omnes delapsi sed eorum cicatrices in ternis inferioribus laterales et in ramorum apicibus singuli.

Specimen typicum in U. S. Nat. Herb. in Guatemala legerunt *O. F. Cook* et *C. B. Doyle*, no. 97, ad Secanquim, in Alta Vera Paz.

***Desmoncus Lundellii* sp. nov.**

Scandens caule sursum vaginis tecto 2.5 cm. diam. nudato ca. 1.7 cm. Folia caulem imbricate vaginantia. Vaginae supra petioli insertionem in ochream apice in fibros dissolutam 18 cm. longam productae, pallide griseo-cinnamomeae, aciculis ex papillis anguste conicis vel subcylindricis orientibus, subascendentibus atris juventate sordide furfuraceo-pubescentibus, longioribus 16 mm. longis dense armatae. Petioli pars libera 2 cm. longa 12 mm. lata et rhachis pars basalis subtus sparsim supra densius aciculatis cum duarum aciculis specierum aut pergracilibus ca. 6 mm. longis aut validis 3.5-5 cm. longis. Rhachis ca. 1.75 m. longa foliolis utrinsecus ca. 20, lanceolatis, acutis, gregatim alternis, infimis ca. 17 cm. longis 2.5 cm. latis; mediis ca. 32 longis 3.4 cm. latis; supremis 26 cm. longis, 3.0 cm. latis; transitionalibus retroflexis 1-jugis 14 cm. longis 4.5 mm. latis; amnibus longitudinaliter subplicatis ca. 20-venosis utrinque obscure transverse venulosis, supra prope basin horride aciculatis, aciculis ca. 20-30, longioribus 3.0-4.0 cm. longis, subascendentibus, etiamque in venae mediae tertia parte basali aciculas 2-4 ferentibus. Cirrhus sparsim longiaciculatus uncos jugatim ferens, basi valde incrassatos, lateraliter compressos, rigidos,

majores 3.5 cm. longos, secus rhachin 11 cm. separatos; intermedios 2.5 cm. longos, 7 cm. separatos; ultimos non visos. Spatha inferior fere glabra apice sparse et appresse breviaciculata. Spatha superior fusiformis 22-30 cm. longa, 3-4 cm. diametens, dense armata, aciculis atris rectis diverse directis majoribus ca. 12 mm. longis. Pedunculus 4-10 cm. longus aciculis subascentibus vestitus. Inflorescentiae pars ramosa 18-20 cm. longa, solum ad basin aciculata ramis simplicibus ca. 30, longioribus 10 cm. longis, hand carnosus valde acutangulatus contortis vel flexuosis. Flores superiores solitarii staminei sessiles bracteolis rigidiusculis subretroflexis .5-1.0 mm. longis subtenti, ex calyce membranaceo gamosepalo, corolla longe pyramidato tripetala et staminibus (9?) constituti, calyce excentrico, horizontaliter 3.3 mm. lato (si applanato), longitudinaliter 2.3 mm. diametente; petalis carnosus, deltoideis 9 mm. longis, longe acutis. Flores inferiores terni unus femineus medius alii 2 staminei (delapsi) lateraliter et superiuscule positi et bracteolis minutis triangulis subtenti. Floris feminei calyx symmetricus membranaceus 3 mm. diam. annuliformis apices subobsoletos sepalorum unitorum obtusissimos obscure exhibentes. Corolla carnosus sympetala cyathiformis 2.8 mm. diam. 2.5 mm. alta, margine minutissime triapiculata. Stamina vel staminodia nulla. Ovarium unilocularium ellipsoideum apice acuto breviter 3-stigmatosum. Fructus ovoideus 13 mm. longus, 11 mm. diametens, pericarpio tenui carnosus, endocarpio osseo paululum supra aequatorem foraminibus 3, placentis parietalibus oppositis, perforatis.

Specimen typicum in Herb. Mich. legit *C. L. Lundell* prope El Paso de Petén, Petén, Guatemala, 26 Apr. 1932.

Desmoncus quasillarius sp. nov.

Scandens, caule vaginato ca. 3 cm. crasso. Vaginae pars supra petioli insertionem (ochrea) ca. 15 cm. longa, apice in fibris dissoluta, griseo-cinnamomea, aciculis atris plerumque quam 1 cm. brevioribus modice tecta. Petiolus 22 mm. longus minus aciculatus quam ochrea. Rhachis ca. 1.9-2.0 m. longa, tenuiter ferrugineo-furfuracea, supra aciculas specierum duarum ferens, paucas compressas fere 14 mm. longas et alias breviores, omnes patentes vel subascentes; subtus solum infra medium spinas longiores pauciores retroflexas 2 cm. longas validas ferens, sursum in cirrum omnino inermem transeans. Foliola subplicata, glabra, utrinsecus ca. 22, inferiora irregulariter aggregata, superiora pariter subalterna vel subopposita; infima 23 cm. longa, 14 mm. lata, supra ad basin barbatim aciculata, aciculis ca. 6-10 longioribus 15 mm. longis, apice longe attenuata, et subtus, caudam apicalem versus, acicula solitaria 13 mm. longa instructa; media ca. 30 cm. longa, 3 cm. lata acuminata ad basin minus barbata, solum 4-6 aciculas, longiores ca. 20 mm. longas, ferentia; suprema 24 cm. longa, 32 mm. lata, basi et apice longe angustata, leviter barbata, aciculas solum 1-3 breves ferentia. Foliola 2 transeuntia in uncis recurvata base incrassata non barbata 18.5 cm. longa 18 mm. lata. Uncorum paria 9 infima 7 cm. longa, inter se 10 cm. distantia, sequentia gradatim breviora et propinquiora. Spatha inferior inermis vel sparsissime et breviter aciculata, ca. 14-18 mm. lata; pars aperta ca. 7 cm. longa. Ramus fertilis infra spatham superiorem sparse et breviter aciculatus. Spatha superior fusiformis ca. 27 cm. longa, 22 mm. crassa, deorsum angusta ferrugineo-furfuracea, breviter (2-4 mm.) aciculata, sursum horride aciculata, aciculis diverse directis plerumque porrectis. Pedunculus 5 cm. longus, patenter et breviter aciculatus, aciculis longioribus ca. 4 mm. longis, haud retrosis. Inflor-

escentiae axis simpliciter ramifer inermis, tenuiter ferruginosus, ramis valde angulatum flexuosus ca. 35, deorsum flores ternatim sursum singulatim ferentibus, gracilibus, haud carnosus. Flos centralis femineus, laterales staminei, omnes bracteola subcartilaginea communi probabiliter composita, anguste lunata, obscure 3-apiculata vel integra, subtenti. Flores feminei conici vel subcylindrici, gamosepali, gamopetali; calyce cupuliformi 2.5 mm. diam. (si non applanato) 1 mm. alto, margine minute et distanter triapiculato; corolla 3.5 mm. alta, 2.3 mm. lata, apice profunde (tertia parte) tricuspidata, apicibus triangulo-subulatis, sinibus rotundatis; staminodiis vestigialibus minutissimis; ovario corollam excedente, anguste ablongo, breviter tristigmatoso. Flores masculi in parte rami floriferi terminali singuli, bracteolis singulis vel binis brevibus acutis divergentibus subtenti. Flores staminei 10–12 mm. longi, calyce membranaceo gamosepalo cupuliformi acute triapiculato, si applanato asymmetrico triangulo, angulis acutis. Petala 3 distincta cartilaginea basi subovata apice subulata longe producta. Stamina 9. Pistillodium nullum.

Specimen typicum fructiferum in Herb. Mich. legit *Percy Gentle*, no. 348, in Dist. Corozal, British Honduras, et specimina alia florentia prope San Andres, Corozal, British Honduras, no. 4750, et fructifera, no. 528.

D. quasillarius is the "basket tie-tie" or "basket whist" of northern British Honduras.

Desmoncus uaxactunensis sp. nov.

Scandens maturitate 5–15 m. altus, caule vaginis tecto ca. 4–5 cm. crasso, nudato 2–3 cm. crasso. Folia caulem imbricate vaginantia. Vaginae sursum in ochream ca. 30 cm. longam, griseo-cinnamomeam furfuraceo-pubescentem, apice demum in fibros disolutam dense aciculis tenuibus atratis subascendentibus 4–18 mm. longis praeditam productae. Aciculae juventate furfuraceae demum nitidae rectae ex papillis bulbiformibus orientes. Petioli para libera ca. 9–12 mm. longa et rhachis pars inferior colore vaginae similes furfuraceo-pubescentes aciculis quam eis vaginae brevioribus postice subsparis antice densius positae obtectae Rhachis ca. 2.25 m. longa, foliolis utrinsecus ca. 25, infimis 25 cm. longis 2 cm. latis; mediis ca. 30 cm. longis 4 cm. latis; supremis ca. 35 cm. longis 4 cm. latis, omnibus utrinque concoloribus vel subtus pallidiusculis, proper margines vel glabratis vel evanescente furfuraceo-pubescentibus, obscure subplicatis, basi angustatis replicatis apice acuminatis, ven media sola prominenti venis aliis longitudinalibus equaliter evidentis supra cum venulis obliquis transversis subtus absque venulis transversis, supra prope basin aciculos ca. 10 graciles atratos 2 cm. longos vel breviores barbatim ferentibus etiamque 2 vel 3 alios in nervo medio infra mediam folii partem. Foliola irregulariter alternantia abrupte per solum 2 intermedia 18 cm. longa 18 mm. lata exacte foliacea sed retrorsa transeuntia in uncis 9-jugis subrigidos lateraliter compressos et applanatos non foliaceos, infimos 6 cm. longos, 15 cm. secus rhachin separatos, supremos 1–2 cm. longos, 1 cm. separatos. Cirrhus in extremitate solum modo unci armatus, deorsum sparsissime spinis gracilibus 2 cm. longis armatus vel subinermis. Ramus fertilis infra spathas semicylindricus 10–13 mm. latus 35–40 cm. longus brunneo-lepidotus omnino in vagina occultus. Spatha inferior etiam semicylindrica, ca. 20 mm. lata, 40 cm. longa, facie plana interiore glabra, pallida, dense longitudinaliter venosa, facie concava tenuiter brunneo-lepidota, apice aperto angustata exfimbriata. Spatha superior fusiformis 28 mm. longa 4 cm. crassa furfuraceo-pubescentem et dense

spinis atratis varie aggregatis in tuberculos sedentibus valde flexuosis vel rectis armata. Inflorescentia spatham superiorem non excedens. Pedunculi pars libera 5 cm. longa, 5 mm. crassa, lepidoto-furfuracea spinis 3-5 mm. longis tenuissimis ascendentibus tecta. Axis in parte inflorescentiae ramosa inermis, furfuraceus, 20 cm. longus, ramulos 40-50 floriferos simplices 4-12 cm. longos valde acute angulatim flexuosos ferens. Flores ad ramuli basin ternatim aggregati, ferior et centralis fertilis, staminei bini laterales. Fructus maturus ovoideus 15 mm. longus 12.5 mm. diametens, minute apiculatus.

Specimen typicum in Herb. Univ. Mich. conservatum legit *H. H. Bartlett* in vicinitate oppidi Uaxactun Mayarum antiquorum, Petén, Guatemala, 18 Apr. 1931, no. 12576.

Desmoncus unaxactunensis differs from the closely related *D. chinantlensis* Liebm. most obviously in the much more slender and more sharply zig-zagged branches of the fruiting inflorescence. Under a lens the prophyllum subtending the flower groups is seen to have a sharply triangular retrorse tip which is lacking in *D. chinantlensis*. The beard of slender spines on the base of the top of the lamina consists of a larger group of more closely placed spines. Doubtless other distinctions of flowers and fruit would be obvious if more complete material of *D. chinantlensis* were available for comparison.

Desmoncus ferox sp. nov.

Scandens gracilis, 2 cm. crassus, caule vaginis oblecto. Pars vaginae superior (ochrea) 25 cm. longa, apice demum in fibris dissoluta, sordide albida ferrugineo-furfuracea et dense armata, spiculis ca. 12-22 mm. longis, atris, gracilibus, juventate derosum pubescentibus, basi ex tuberculis cylindricis orientibus. Petioli pars libera 2-3 cm. longa Rhachis tenuiter ferrugineo-pubescentis supra aciculis interdum 20-28 mm. longis armata subtus subinermis vel spiculis multum brevioribus praedita, ca. 2.5 m. longa, utrinque usque ad cirrhum (ca. 1 m. longum) foliolos ca. 24 ferens. Foliola inferiora ca. 30 cm. longa, 1.5 cm. lata longe attenuata in caudam filiformem 8 cm. longa; intermedia ca. 29 cm. longa 4 cm. lata, apice solum acuminata non filiformi-caudata; superiora ca. 36 cm. longa, 46 mm. lata acuminata sed sub lente bifida vel praemorsa; omnia longitudinaliter subplicata et venosa, utrinque sub lente tenuissime minutissimeque atropubescentia et transverse venulosa, subtus inermia, supra prope basin ferociter multiaciculata, aciculis longitudine eis vaginae rhachisque similibus interdum 30 mm. longis, utrinque acicula sola brevi (ca. 8 mm. longa) in vena media infra folioli medium instructa. Foliola in uncis transeuntia solum 2 subopposita, foliacea, 27 cm. longa, 12 mm. lata, basi uncis similiter tumida et reflexa. Uncorum paria 10, rigida, lateraliter compressa, inferiora 9 cm. longa 26 cm. inter se distantia, intermedia 4.5 cm. longa, 7 cm. distantia. Spatha inferior 22 mm. lata, pars clausa plus quam 21 cm. longa, pars aperta 13 cm. longa, sursum ferrugineo-furfuracea et mediocriter aciculata, aciculis de causa compressionis in vagina plerisque appressis sed prope orificium patentibus 7 mm. longis. Ramus fertilis infra spatham superiorem 11 mm. crassus, appresse et breviter aciculatus, ferrugineus. Spatha superior fusiformis, ca. 40 cm. longa, 3 cm. diametens, cinnamomeo-albida et ferrugineo-furfuracea, apice breviter filiformi-caudata, deorsum appresse et breviter aciculata sursum valde horride patenter aciculata, aciculis

atratis, diverse directis, longioribus 18 mm. longis. Pedunculus ca. 7 cm. longus deorsum inermis sursum aciculatus, aciculis majoribus 13 mm. longis. Axis inflorescentiae pars ramosa ca. 24 cm. longa, inermis, albida et tenuiter ferrugineo-pubescentis, ramos ca. 40 inferiores 15 cm. superiores 6 cm. longos simplices floriferos ferens, ramis (siccis) angulatis, valde angulatim flexuosis, deorsum flores sessiles ternatim sursum singulatim ferentibus. Flores feminei centrales inter 2 masculos siti depresso-globosi 3 mm. lati 2.5 mm. alti gamospali gamopetali. Calyx subrotundus annulatus breviter margine 3-apiculatus symmetricus 3.3 mm. diam. Corolla cyathiformis margine contracta ovarium includens sessile breviter 3-stigmatosum. Staminodia nulla. Flores staminei calyce gamosepalo membranaceo symmetrico 3.5 mm. diametiente fere perfecte triangulo, angulis productis acuminatis, petalis 3 distinctis carnis deltoideis, 8-10 mm. longis, acuminatis, basi 1.5-3.0 mm. latis, latoribus subcordatis. Stamina 9, sagittata, filamentis 1 mm. longis tenuissimis antheris profunde sagittatis gravidis 2 mm. longis, i.e. corolla occultis. Pistillodium nullum.

Specimen typicum ad oppidum Mayarum antiquorum Tikal lectum, Petén, Guatemala, *H. H. Bartlett* 12584, 12-15 Apr. 1931, in Herb. Mich.: La Libertad, Petén, Guatemala, *C. L. Lundell* 2646 (6 Apr. 1933; florens) et 3421 (27 Maiæ 1933, cum fructibus).

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

518TH MEETING

The 518th meeting was held at the Cosmos Club October 31, 1934, Vice-President GOLDMAN presiding.

Informal communications: L. G. HENBEST showed lantern slides of pseudomorphs of halite from the De Queen limestone member of the Trinity formation, De Queen, Arkansas.

Program: W. T. SCHALLER: *Kramer borate deposits, California*. Discussed by Messrs. GOLDMAN, JOHNSTON, HENDRICKS, R. C. WELLS, GILLULY, HEWETT, and BAILEY.

R. C. WELLS: *The abundance of certain elements, especially radioactive elements, and related geologic problems*. The first attempt to compute the average chemical composition of known terrestrial matter was made by F. W. Clarke in 1889. Chemists have been adding to the compilation ever since. A recent publication by the Russian chemist A. E. Fersman lists the average abundance or scarcity, as the case may be, of 88 elements, and if account is taken of isotopes, there are now 262 species of matter to be considered. More elements occur in ten-thousandths of a percent than in any other rank of abundance. The radioactive elements have been of great aid in determining the abundance of several elements. These elements have pedigrees. Also, as they evolve heat continuously, there must be a definite limit to their quantity in the earth. They appear to be concentrated near the surface and hence it may be inferred that there is a similar limit to the abundance of elements generally associated with the radioactive elements in the earth's crust. Recent work in the Geological Survey has involved